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Attorney's Docket No. OLEKSY, HENRYK **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of
Inventor(s): HENYRK OLEKSY

WARNING: *Patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41(a) and 1.53(b).*

For (title): A PROCESS FOR CONTOUR CONTROL MACHINING OF METAL BLOCKS

CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this New Application Transmittal and the documents referred to as enclosed therein are being deposited with the United States Postal Service on this date JANUARY 5, 2000, in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EL 435108383US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Leon I. Edelson
(type or print name of person mailing paper)

Leon I. Edelson
Signature of person mailing paper

NOTE: Each paper or fee referred to as enclosed herein has the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 CFR 1.10(b).

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 CFR 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

1. Type of Application

This new application is for a(n)

(check one applicable item below)

☒ Original (nonprovisional)

☐ Design

☐ Plant

WARNING: ***Do not*** *use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.*

WARNING: ***Do not*** *use this transmittal for the filing of a provisional application.*

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

☐ Divisional.

☐ Continuation.

☐ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: *If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b) for a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.*

WARNING: *When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application* ***must*** *be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).*

☐ The new application being transmitted claims the benefit of prior U.S. application(s) and enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed That Are Required for Filing Date under 37 CFR 1.53(b) (Regular) or 37 CFR 1.153 (Design) Application

8 Pages of specification

1 Pages of claims

1 Pages of Abstract

5 Sheets of drawing

☐ formal

☒ informal

☐ Application is made by a person authorized under 37 CFR 1.41(c) on behalf of *all the above named inventor(s).*

(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently).

NOTE: It is important that all the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).

☐ Showing that the filing is authorized.
(not required unless called into question. 37 CFR 1.41(d))

6. Inventorship Statement

WARNING: *If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.*

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of $130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37 CFR 1.69(b).

☐ English

☐ Non-English

☐ The attached translation is a verified translation. 37 CFR 1.52(d).

8. Assignment

☐ An assignment of the invention to _____

_____

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: *A newly executed "CERTIFICATE UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.*

WARNING: ***DO NOT*** *submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. Comments on proposed new 37 CFR 1.84. Notice of March 9, 1988 (1990 O.G. 57-62).*

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page." 37 C.F.R. 1.84(c)).

(complete the following, if applicable)

☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).

4. Additional papers enclosed

☐ Preliminary Amendment

☐ Information Disclosure Statement (37 CFR 1.98)

☐ Form PTO-1449

☐ Citations

☐ Declaration of Biological Deposit

☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.

☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

☐ Special Comments

☐ Other

5. Declaration or oath

☒ Enclosed

Executed by

(check **all** *applicable boxes)*

☒ inventor(s).

☐ legal representative of inventor(s). 37 CFR 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. *See* item 13 below for fee.

☐ Not Enclosed.

WARNING: *Where the filing is a completion in the U.S. of an International Application, but where a declaration is not available, or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.*

9. Certified Copy

Certified copy(ies) of application(s)

country	appln. no.	filed
country	appln. no.	filed
country	appln. no.	filed

from which priority is claimed

☐ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 CFR 1.16)

A. ☒ Regular application

CLAIMS AS FILED			
Number filed	Number Extra	Rate	Basic Fee 37 CFR 1.16(a) $750.00
Total Claims (37 CFR 1.16(c)) – 20 =	×	$ 22.00	
Independent Claims (37 CFR 1.16(b)) – 3 =	×	$ 78.00	
Multiple dependent claim(s), if any (37 CFR 1.16(d))	+	$250.00	

☐ Amendment cancelling extra claims enclosed.

☐ Amendment deleting multiple-dependencies enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation $ $345

B. ☐ Design application
($310.00—37 CFR 1.16(f))

Filing Fee Calculation $_____

C. ☐ Plant application
($510.00—37 CFR 1.16(g))

Filing fee calculation $_____

11. Small Entity Statement(s)

☒ Verified Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

WARNING: *"Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121 or 365(c) of a prior application may rely on a verified statement filed in the prior application if the nonprovisional application includes a reference to a verified statement in the prior application or includes a copy of the verified statement filed in the prior application if status as a small entity is still proper and desired." 37 C.F.R. § 1.28(a).*

(complete the following, if applicable)

☒ Status as a small entity was claimed in prior application 60 / 114,916, filed on Jan. 5, 1999, from which benefit is being claimed for this application under:

35 U.S.C. ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

☐ A copy of the verified statement in the prior application is included.

Filing Fee Calculation (50% of **A, B** or **C** above) $345

NOTE: Any excess of the full fee paid will be refunded if a verified statement and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).

12. Request for International-Type Search (37 CFR 1.104(d))

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.
(This and the surcharge required by 37 CFR 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Basic filing fee	$ 345
☐ Recording assignment ($40.00; 37 CFR 1.21(h)) (See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".)	$ _____
☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached. ($130.00; 37 CFR 1.47 and 1.17(h))	$ _____
☐ For processing an application with a specification in a non-English language. ($130.00; 37 CFR 1.52(d) and 1.17(k))	$ _____
☐ Processing and retention fee ($130.00; 37 CFR 1.53(d) and 1.21(l))	$ _____
☐ Fee for international-type search report ($40.00; 37 CFR 1.21(e))	$ _____

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78, indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(d).

Total fees enclosed $_____

14. Method of Payment of Fees

☒ Check in the amount of $ 345

☐ Charge Account No. _____ in the amount of $_____.
A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: *If no fees are to be paid on filing, the following items should not be completed.*

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.*

☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 05-0423 :

☐ 37 CFR 1.16(a), (f) or (g) (filing fees)

☐ 37 CFR 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: *Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.*

☐ 37 CFR 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☐ 37 CFR 1.17 (application processing fees)

WARNING: *While 37 CFR 1.17(a), (b), (c) and (d) deal with extensions of time under § 1.136(a), this authorization should be made only with the knowledge that: "Submission of the appropriate extension fee under 37 C.F.R. 1.136(a) is to no avail unless a request or petition for extension is filed." (Emphasis added). Notice of November 5, 1985 (1060 O.G. 27).*

☐ 37 CFR 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 CFR 1.311(b))

NOTE: *Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).*

NOTE: *37 CFR 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee." From the wording of 37 CFR 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.*

16. Instructions as to Overpayment

☒ Credit Account No. ____________

☐ Refund

Reg. No. 38,863

Tel. No. (312) 849.3333

SIGNATURE OF ATTORNEY

Leon I. Edelson

(type or print name of attorney)

P.O. Box 2465

P.O. Address

Chicago, IL 60690-2465

☐ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added____________________

☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added____________________

☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added____________________

☒ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item.)

☒ This transmittal ends with this page.

CERTIFICATE OF MAILING
(PATENT)

Express Mail No. EL435108383US

Deposited: January 5, 2000

I hereby certify that the attached correspondence, identified below, is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, DC 20231.

By: Lewis T. Edelson

Patent Application of: Henryk Oleksy

Title: A Process for Contour Control Machining of Metal Blocks

x Patent Application (8 pages of specification,1 page of Abstract, 4 claims, 5 sheets of drawings)

x Postcard

x Transmittal Letter

x Check

_ Information Disclosure Statement

x Small Entity Form

_ PTO Form 1449

__ Preliminary Amendment

x Declaration and Power of Attorney

_ Other

LIE Client No.: OLEKSY,HENRYK/MILLINGPROCESS/SN60/114,916

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant or Patentee: Henryk Oleksy

Serial or Patent No. 60/114,916 Filed or Issued: January 5, 1999

For: A PROCESS FOR CONTOUR CONTROL MACHINING OF METAL BLOCKS

Attorney's Docket No. Oleksy, Henryk

DECLARATION CLAIMING SMALL ENTITY STATUS
(37 C.F.R. § 1.9(f) AND § 1.27(b)) - INDEPENDENT INVENTOR

As a below-named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 C.F.R. § 1.9(c) for purposes of paying reduced fees under § 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled: A PROCESS FOR CONTOUR CONTROL MACHINING OF METAL BLOCKS described in

[x] The specification filed herewith
[x] Application Serial No. 60/114,916, filed on January 5, 1999
[ ] Patent No._____, issued _____

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 C.F.R. § 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 C.F.R. § 1.9(d) or a nonprofit organization under 37 C.F.R. § 1.9(e).

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 C.F.R. § 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing therein, or any patent to which this verified statement is directed.

Henryk Oleksy
NAMES OF INVENTORS

Henryk Oleksy
Signatures of Inventors

OFFICIAL SEAL
LEON I. EDELSON
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 1-15-2002

Subscribed and sworn to before me this 5th, day of January, 2000.

Leon I Edelson
Notary Public

Date: 1-5-2000

Law Office of Leon I. Edelson, 39 S. LaSalle Street, Suite 1120,Chicago, IL 60603-1706
Tel 312. 849.3333; Fax 312.849.3399; E-mail leoniplaw@aol.com

A Process for Contour Control Machining of Metal Blocks

This application claims the benefits of Provisional Patent Application Serial No. 60/114,916, filed January 5, 1999.

Background of the Invention

The present invention relates to the machining of engineering components having complex curved shapes and particularly to the machining of components having multiple complex curved surfaces in a single engineering component such as the root section of turbine blades.

When a root section of a turbine blade is produced by machining, the machining can be in several procedures, each requiring a separate machining operation with separate set-up requirements. These procedures can include cutting of the material stock to rough required shape, milling to required dimensions of the required stock dimensions, de-burring, grinding, machining again to required dimension; roughing the root section of the turbine blade by milling, rough and finish milling of the hook curvature of the root section, a final taper machining and hand grinding with sides milling to obtain the finished root section of a turbine blade. The finished root section of the turbine blade itself often has to satisfy allowable tolerances pertaining to that particular dimension, thickness, shape and curvature.

Presently, the method of preparing these root sections of a turbine blade with the many successive machining operations requires separate tolerance measurements, separate machining operations and multiple set-ups. The instant invention has been devised with the view to substantially eliminating the many separate procedures inherent in the prior art of machining root sections of turbine blades and has as its essential object an improved method for machining the root section of a turbine blades on a vertical or horizontal machining center with rotary table.

Summary of the Invention

In the machining of certain metal objects, such as turbine blades, machine gears with multi-faceted contours, multiple surfaces can be required to properly meet design requirements such as concave and convex surfaces, which meet and co-exist upon the same planar surface. In the process of manufacturing such metal objects with continuous planar surfaces, co-existent concave and convex surfaces are typically prepared by milling a metal block with a milling machine to prepare the required planar curved surfaces with high accuracy.

The instant invention comprises a process for contour control machining of metal blocks by providing a control procedure for standard computer numerical control conventional milling machines to machine convex and concave curvature on a vertical machining center with rotary table or horizontal machining center with integrated rotary table.

The instant invented process reduces the number of separate procedures required in a conventional machining procedure using a conventional milling machine by permitting all metal

cutting and machining steps to be done on a vertical or horizontal machining center. All cutting, grinding and machining is performed on one milling machine in contrast to the use of more than one cutting machining, grinding, and milling machine required in a conventional process.

Brief Description of the Drawings

Figure 1 is a perspective view of turbine buckets mounted upon a rotary fixture with the form cutter displayed;

Figure 2 is a perspective of turbine buckets mounted upon a rotary fixture with a form cutter approaching (angle –Q)° cutting operation;

Figure 3 is a perspective of a turbine bucket mounted upon a rotary fixture with a form cutter engaged in a cutting operation; (angle 0)°;

Figure 4 is a perspective view of turbine buckets mounted upon a rotary fixture with the form cutter ending the cutting at angle +Q°;

Figure 5 is a more detailed diagram of the Figures 2, 3 and 4.

Figures 2, 3, 4 and 5 accordingly illustrate the control process as applied to the hook curvature required of the turbine blade base to permit installation of the turbine blade member upon a turbine rotor.

Figures 2, 3, 4 and 5 detail the process of programming a milling machine to cause the milling machine to mill concave and convex surfaces to cause the resulting root section of the turbine blade to be mounted upon a turbine rotor in a precise fit.

Detailed Description

The invention comprises computer aided program for a milling machine to machine precise concave and convex surfaces within a metal block so as to form the base section of a turbine blade, called the root section (1). The root section of the turbine blade is designed to fit within precise tolerances upon a circular turbine wheel. The rotation of the rotor in use generates extreme centrifugal force. The separate construction of turbine blades, requires that the fit of the turbine blades upon the rotor be within precise limits and that the separate turbine blade components be identical to avoid misalignment of the turbine rotor with possible vibration during operation.

The root section of the turbine blade is designed to fit within precise tolerances upon a circular rotor. Because of the curvatures of the mating surface of the root section of the turbine blade and the mating section of the circular rotor, the machining of the root section of the turbine blade requires convex movements of the form cutter tool (9) and the rotating of the rotary table (7) which holds the turbine blades. The form cutter (9) travels on a convex line (center line, See Figure 5) from point A to point L following convex pad (E+R), the form cutter spins and

machine simultaneously rotates from angle –Q° to angle +Q°, (See Figure 5) this operation can be also approached at point L and finished at point A.

Reference to Figures 2, 3, 4 and 5 illustrates the movements described above. The form cutter will engage the blank root section (See Figure 2) which is to be approach at Point A (See Figure 5) and will effectively be positioned to engage the root section along the convex line extending to the left which, in Figure 5, passes through Point L. However, because of the rotation of the rotary table from angle –Q° through angle +Q° the form cutter will engage the root section along the convex pad (E+R) extending to the left of Figure 5 through the midpoint of Figure 5 at Point C.

At Point C, the effect of the rotary motion of the rotary table in the opposite rotary angle of +Q° occurs and the form cutter engages the root section along the line from Point C to Point L.

The position of the rotary form cutter is moved closer to the root section as is required to cut the three identical cut surfaces which form holding keys. Reference to Figure 5 explains the movement of the form cutter. As shown in Figure 5, radiuses R, R+D1, and R+D2 are radiuses on the part and are depicted by Figures 1, 2, 3, and 4.

The details of Figure 5 are as follows:

E + R = Value of convex radius obtained from construction of points L, C, and A; (shown as a center line)
L = Minimum distance P and distance M determined by angle +Q°;
C = Minimum distance E determined by angle 0°;
A = Minimum distance F and distance Y determined by angle –Q°;
V = Distance from point L (center of cuter) to corner of part after rotation;
M = Distance from point L to center of the rotation;
S = Distance from corner of taper side to center of gravity (dimension from Figure 5 drawing);
K = Distance from center of gravity to straight side (dimension from Figure 5);
G = Smaller pitch of blade (dimension from Figure 5);
Y = Distance from center of the rotation to point A;
W = Distance from point A to corner of part after rotation;
D1 = Distance from first hook to middle hook (dimension from Figure 5);
D2 = Distance from first hook to third hook (dimension from Figure 5);
R = Radius on first hook (dimension from Figure 5) holding key;
E = Distance from center of rotary table to first hook holding key;
-Q° = Angle of rotation to the right (needs to be chosen accordingly so W is greater than the radius of the cutter);
+Q° = Angle of rotation to the left (needs to be chosen accordingly so V is greater than the radius of the cutter;
P = Distance from center of rotary table to point L;
F = Distance from center of rotary table to point A;

J = Distance from the end of the blade after machining to the center of the rotary table (actual measured distance);

N = Distance from the end of the blade to the first hook measured in the centerline (dimension from Figure 5).

The invented process uses a commercially available computer program for the process for machining the root sections of the turbine blades.

Commercially available program(s) can be used with a vertical or horizontal machining center with standard controls as an operating system. The program is used, based upon a trigonometric construction developed as indicated in Figures 2, 3, 4 and 5. As a particular example, program typing in manual mode by operator, points coordination's (A and L), angles (+Q° and –Q°) and radius (E+R) are obtained by CAD simulation program as follows:

G00G90X0.Y-1.7921Z2.A85.2
G00Z-1.7011 M8;
G02X0.Y1.7921Z-1.7011R21.417A94.8F.003

In detail, the method of making the CAD simulation is as follows:

The general systematic explanation of making CAD simulation using variables is as follows:

Radiuses R, R + D1, and R + D2 are radiuses to machine on the part and are depicted by Figure 5

A first trapezoid (continuous line) with three extended radiuses (R, R + D1, R + D2) is drawn in angle 0°; D1 is the distance from first hook (10) to middle hook (11). D2 is the distance from the first hook to a third hook (12). This operation is applicable to turbine buckets with any number of hooks.

A second trapezoid (dash-dot line) with three radiuses is the rotated copy of the first Figure with radiuses to angle –Q°.

A third trapezoid (hidden line) with radiuses is the rotated copy of the first Figure with radiuses to angle +Q°.

For both rotations, the center of rotation is the center of the rotary table.
Point C is defined by minimum distance E
Point A is defined by minimum distance F
Point L is defined by minimum distance P
From the construction of points L, C, and A, a new radius valued E + R is determined
In this point, the value of the new constructed radius is the sum of radius E + radius R
Radius E is the distance from the center of rotation (center of rotary table) to the hook with radius R. The radius valued E + R is trigonometrically constructed;
The radius R is concave and radius E + R is convex. Dimension E can be chosen or determined after the setup is done but must be known to make this construction. Dimensions V & W are

determined by the angle +Q° & -Q°. These dimensions have to be greater than the radius of the cutter so the cutter can clear the part when it approaches.

Figures 2, 3, 4 and 5, describe one machining cutting pass for machining the curvature on the hooks as determined b the controlling programming in use.

The form cutter approaches the turbine bucket at point A of angle –Q°. The position of the root section (1) and fixture is on angle – Q°. See Figure 2. From this point, the form cutter travels (and cutter spins simultaneously) in radius E + R (convex line) to point L. (See Figure 3, 4, and 5) and rotary table simultaneously rotates left to angle +Q°. This operation can be approached at point L and finished at point A.

In a machine cutting by the invented method, the cutter centerline is constantly 90° to theoretical line which is tangent to arc in the cutting point. This action is obtained in two conventional methods for machining the curvature on the hooks by manual machines. One of them is the spindle on a pivot. The distance from the cutter to the pivot controls the radius machined on the hooks. In this method, the turbine bucket is a stationary part. In the second method, the turbine bucket(s) are installed on a rotary table and the radial position on the table controls the radius on the hooks. The CAD programming for machining and machining the curvature on the hook(s) is the main factor that makes the process possible to machine the root section of the turbine buckets completely in one setup.

This method described above using CAD programming completely machines the root section of rotating turbine buckets on a three axis computer numerical control vertical machining center with rotary table for small turbine buckets or three axes computer number control horizontal machining center with integrated rotary table for large turbine buckets.

In contrast, the prior art for machining the root section of a turbine blade can be as follows:

1. Cutting material
2. Machining on thickness (milling)
3. Deburring by hand
4. Grinding on thickness
5. Machining on width (milling)
6. Deburring by hand
7. Grinding on width
8. Roughing book's shape and tang fits (milling)
9. Rough taper machining (milling)
10. Machining hook's curvature [(rough and finish) milling]
11. Final taper machining on sinus table (milling)
12. Hand grinding corners on dovetail shape
13. Sides machining (milling)
14. Steam balance machining if required

These fourteen steps are separate and required to be moved for one machine to another for each step.

In the instant invention, all steps can be done on the vertical machining center with rotary table (for smaller buckets) or horizontal machining center with main rotary table (in this machine, the rotary table is larger and more rigid and is more suitable for larger buckets) with the following procedure:

1. Cutting material
2. Grinding on thickness (one side only) to clean up
3. Machining & one setup for complete root section (rough and finish);
    A. Taper side machining (rough and finish)
    B. Straight side finish
    C. Roughing hooks and machining tang fits to finish or with stock
    D. Machining curvature on hooks (rough and finish) using special programming
    E. Machining sides to finish
    F. Machining corners on dovetail shape (hand operation in previous process)
    G. Steam balance hole machining also can be done in this setup if required

By comparing both methods, one can see fewer people are required, the product is made more precisely, and it is easier to control quality during production. In the invented process, it is possible to concentrate many operations into one setup because step D is possible to do in an integrated step.

In the prior art, this operation of Step D had to be separate. The way it was done, the part was mounted on the fixture in proper radial position. This radial position determined the radius machined on the hooks.

In the present method, the bucket is mounted in the fixture as in Figures 1, 2, 3 and 4 on the other side of rotation. In one radial position, any radius can be machined. For programming operation D, I decide to use a CAD simulation (Figure 5) to obtain coordination of points A & L, rotation angles +Q & -Q and the value of the convex radius E + R.

To make this CAD simulation, the radius R is used, this is the radius on the first hook. All three radiuses R, R + D1, R + D2 are drawn from the same center (this information is from the drawing). The form cutter used for machining the radiuses has to have the same distance between the cutting edges as is between the hooks. This means that if the cutter is constantly 90° to theoretical tangent line in the cutting point on radius R, it is also 90° to theoretical tangent line in the cutting point to radius R + D1 and radius R +D2.

For this trigonometric construction, radius R, R + D1, or R +D2 can be used. Dimension E will change accordingly and needs to be measured from the center of rotation to the quadrant of the radius that is used for the construction.

The number of hooks does not limit this method as long as all radiuses are drawn from the same center.

The example of CAD was used as an example only. Rather, it the path of the tool which will always be the same regardless of what method is used to find the needed coordination points, angles and radius the sum of E + R. See Figure 5 and it is this that is the claimed invention.

Even if extremely short straight lines are used instead of the curved radius (E + R) as a tool path, the coordination of the end points will describe the points which still fall on the radius (E + R). Using extremely short lines instead of the curved radius (E + R) is just a different way to do the process described above. This method is an alternative method.

By using the operation described above, it becomes possible to machine the entire root section of turbine blades in one or more machine setups.

A. Taper side machining
B. Straight side machining
C. Roughing hooks and machining tang fits to finish or with stock
D. Machining curvature on hooks using the process described above
E. Machining sides to finish
F. Machining corners on dove tail shape
G. Steam balance hole machining can also be done in this setup if required

The order of the operation A – G can be changed if necessary and steps can be added or removed if required.

The entire machining process for machining turbine blade root sections in one setup or multiple setups (to use other machines) is an aspect the instant invention of the instant invention.

What is claimed:

1. A method of determining machining instructions during machining of a workpiece using a machine having a cutter, the surfaces of the workpiece being defined by a plurality of programmed instructions obtained by trigonometric analysis of required curvatures of the surfaces;

2. The method of Claim 1 wherein said trigonometric analysis of the required curvatures of the surfaces comprises a graphical construction of the required surfaces relative to the application of the cutting tool to the required curvatures of the root section of the turbine blade, said graphical construction consisting essentially of a trigonometric analysis, said root section comprising at least one hook holding key;

3. The method of Claim 1 wherein said trigonometric analysis of the required curvatures of the surfaces determines the path of said cutter as a curved convex radius of E plus

R wherein E is the distance form center of rotary table to first hook and R is the radius on the first hook holding key.

4. The method of Claim 1 wherein said trigonometric analysis of the required curvatures of the surfaces determines the path of said cutter as a curved convex radius of E plus R wherein E + R of the convex radius is determined by points L, C, and A, L being the minimum distance P and distance M determined by angle +Q°, the angle of rotation to the left, C being the minimum distance E determined by the angle 0°; A being the minimum distance F and distance Y determined by angle -Q°, the angle of rotation to the right.

Abstract

A method of determining machining instructions during machining of a workpiece suing a machine having a cutter, the surfaces of the workpiece being defined by a plurality of programmed instructions obtained by trigonometric analysis of the required curvatures of the surfaces.

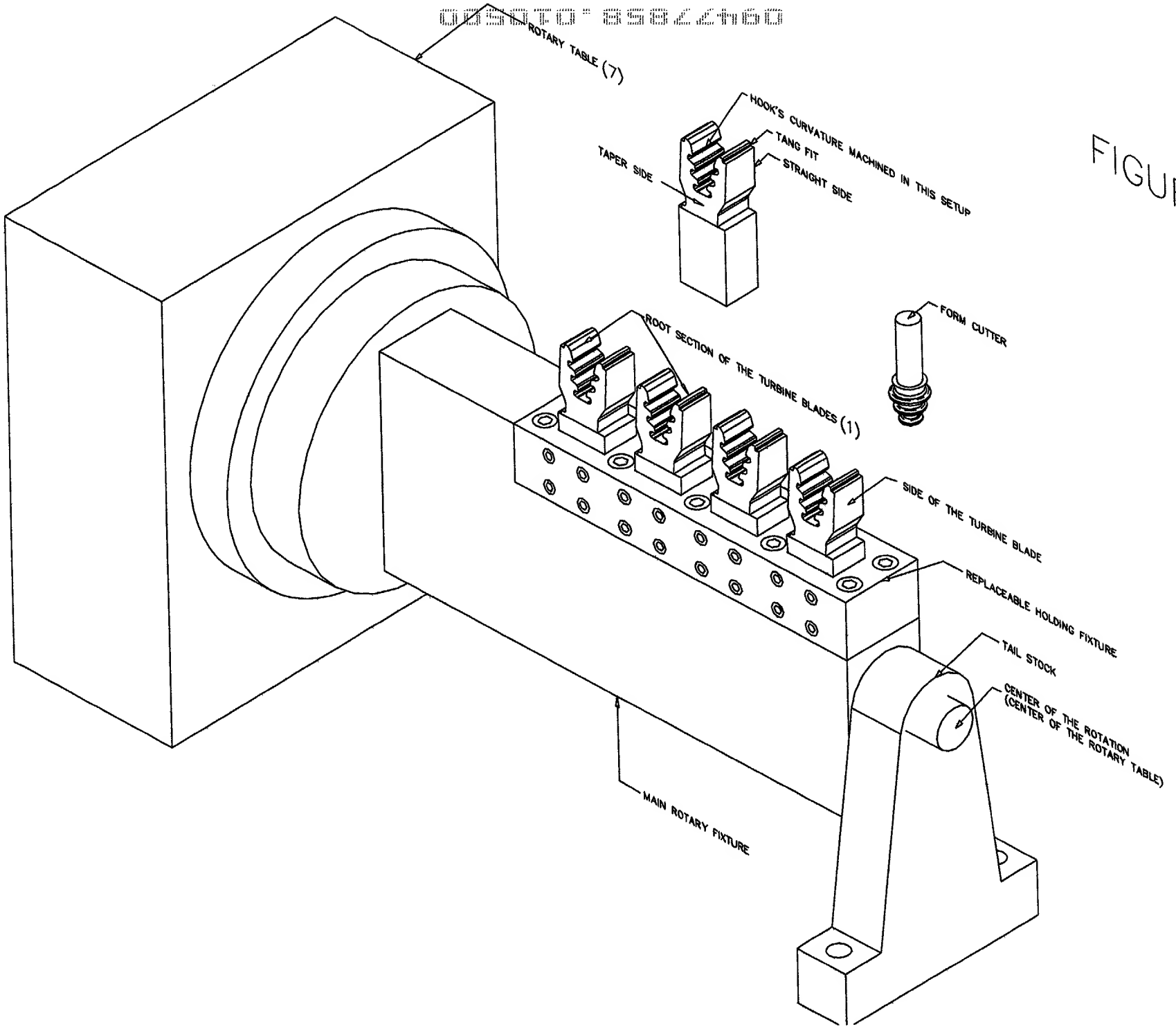


FIGURE 1

FIGURE ②

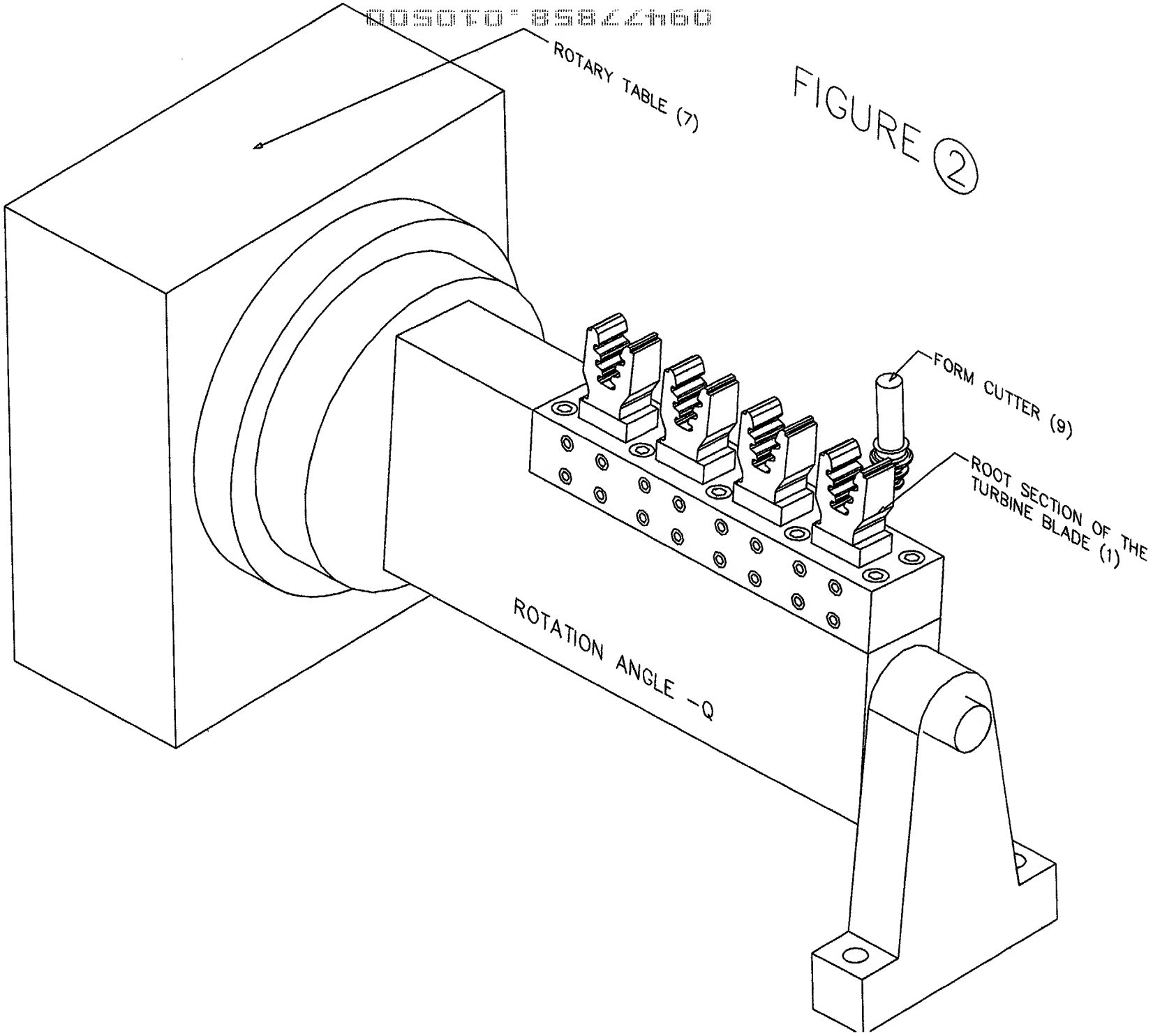
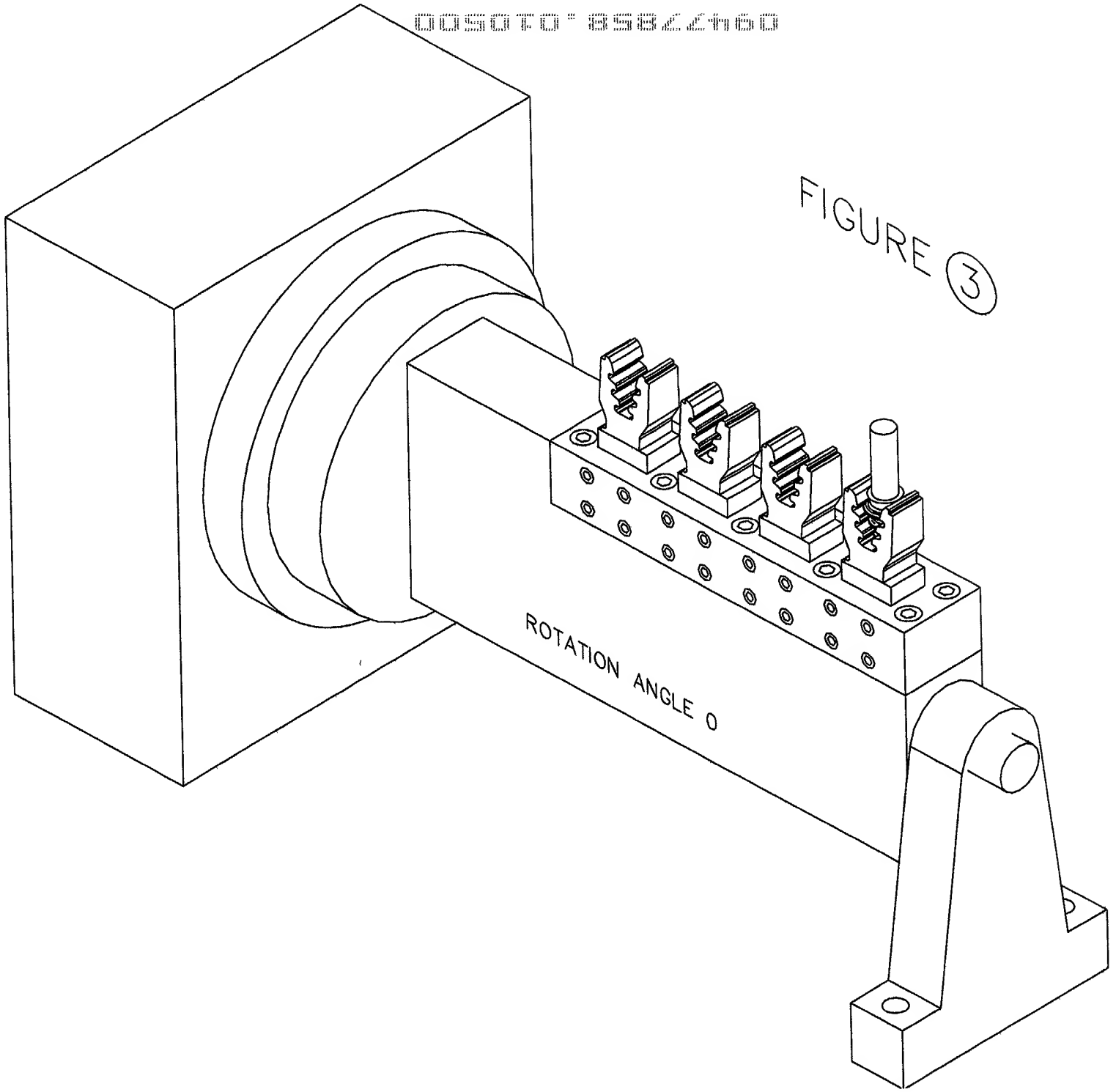


FIGURE (3)



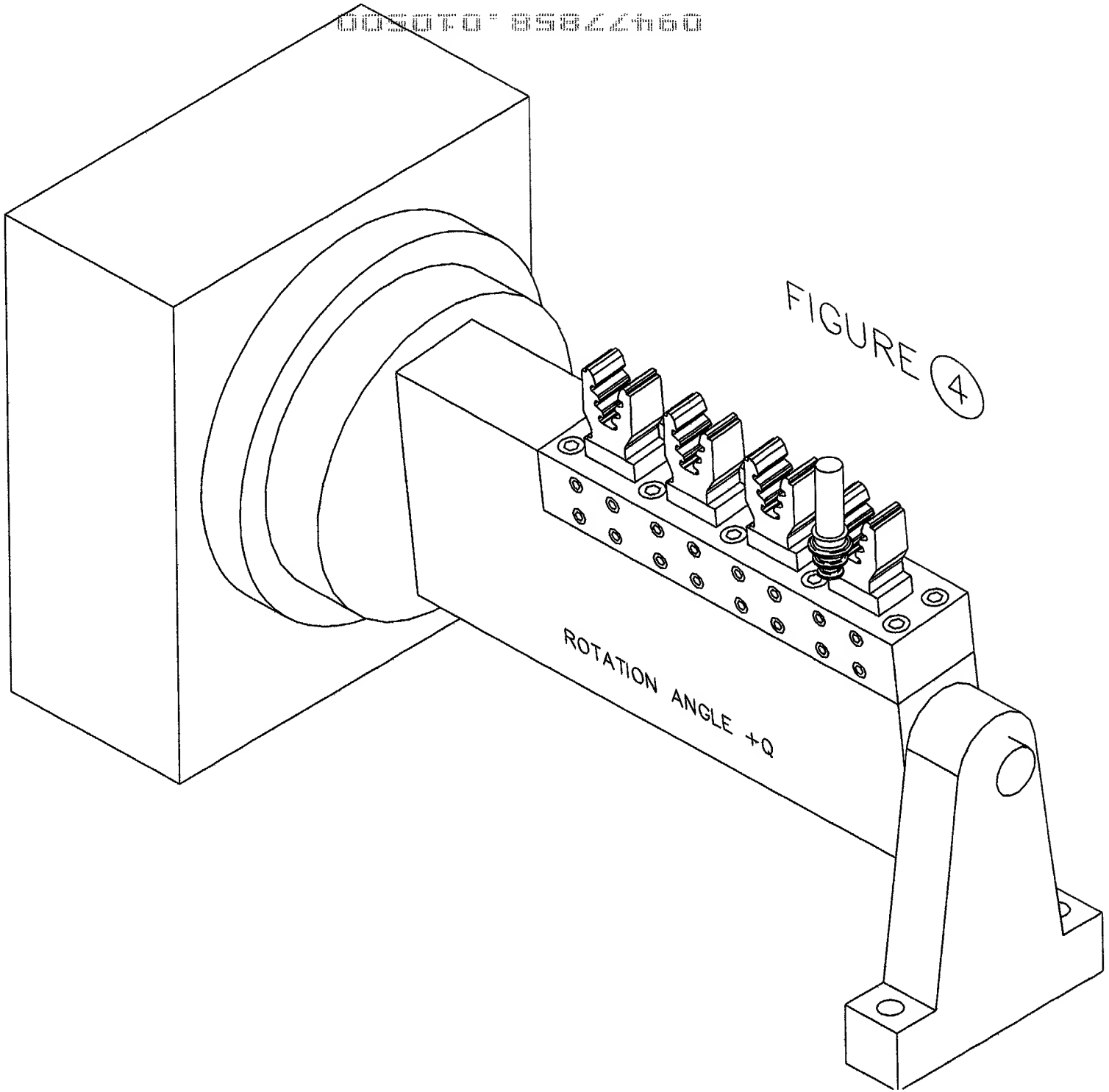
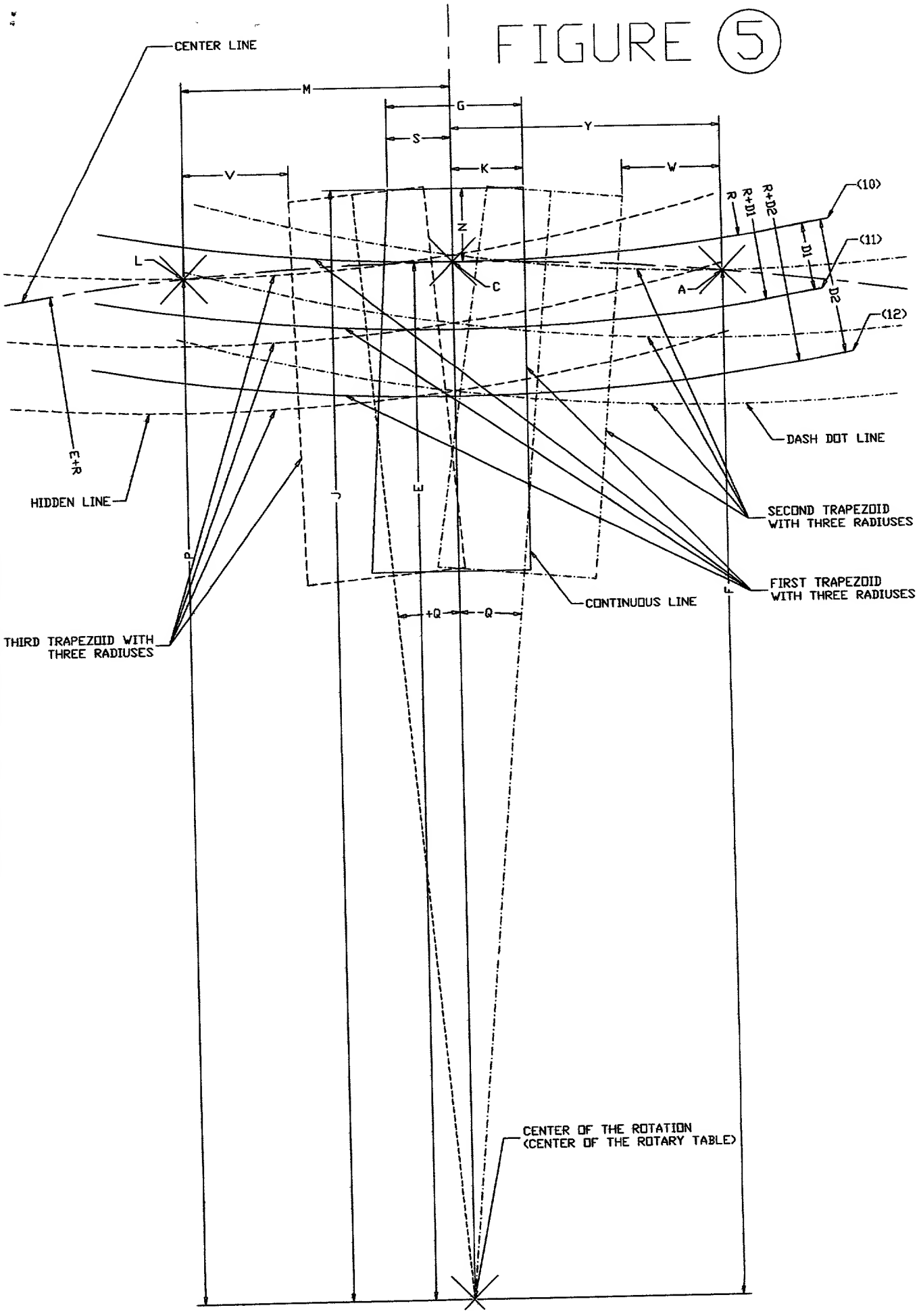


FIGURE 4

FIGURE 5


CENTER LINE
M
G
S
Y
V
K
W
R
R+D1
R+D2
(10)
(11)
(12)
D1
D2
N
L
C
A
E+R
HIDDEN LINE
P
J
E
F
DASH DOT LINE
SECOND TRAPEZOID
WITH THREE RADIUSES
FIRST TRAPEZOID
WITH THREE RADIUSES
CONTINUOUS LINE
+Q
-Q
THIRD TRAPEZOID WITH
THREE RADIUSES
CENTER OF THE ROTATION
(CENTER OF THE ROTARY TABLE)

DECLARATION AND POWER OF ATTORNEY

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and joint inventor of the subject matter, which is claimed in the attached application and for which a patent is sought on the invention entitled:

A PROCESS FOR CONTOUR CONTROL MACHINING OF METAL BLOCKS

the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to the patentability of the claims of this application in accordance with Title 37, Code of Federal Regulations, Sections 1.56(a) and 1.56(b).

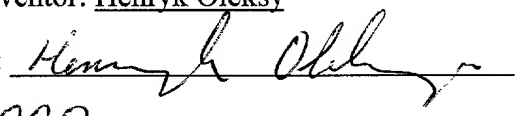
The undersigned hereby appoints the following:

Leon I. Edelson Reg. No. 38,863

mailing address and telephone number is Leon I. Edelson, Law Office of Leon I. Edelson, P.O. Box 2465, Chicago, Illinois, 60690-2465, Telephone Number 312.849.3333, with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of first inventor: Henryk Oleksy

Inventor's signature: 

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